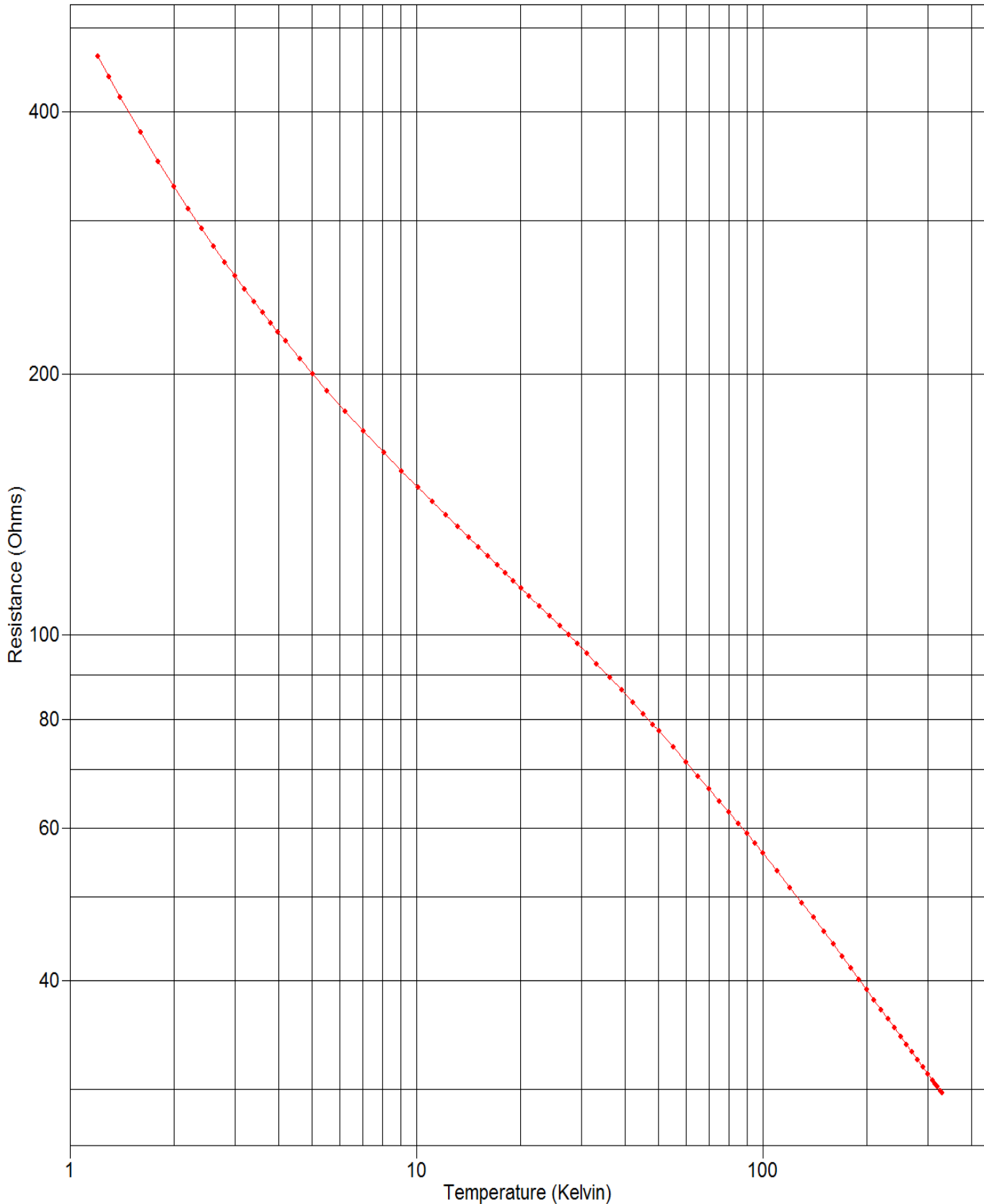


DATA PLOT

Calibration Report: 661202
Sensor Model: CX-1010-CU-1.4L
Sensor Type: Cernox Resistor

Sales Order: 70293
Serial Number: X62997
Temperature Range: 1.40K to 325K



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TEST DATA

Calibration Report: 661202

Sensor Model: CX-1010-CU-1.4L

Sensor Type: Cernox Resistor

Sales Order: 70293

Serial Number: X62997

Temperature Range: 1.40K to 325K

Index	Temp. (K)	Resistance (Ω)	Excitation	Index	Temp. (K)	Resistance (Ω)	Excitation
1	1.20489	463.931	2mV \pm 25%	46	42.1597	83.6524	2mV \pm 25%
2	1.29825	439.103	2mV \pm 25%	47	45.1607	81.1753	2mV \pm 25%
3	1.39868	416.199	2mV \pm 25%	48	48.1509	78.9054	2mV \pm 25%
4	1.59953	379.025	2mV \pm 25%	49	50.1535	77.4901	2mV \pm 25%
5	1.80029	350.544	2mV \pm 25%	50	55.1463	74.2543	2mV \pm 25%
6	1.99978	327.983	2mV \pm 25%	51	60.1447	71.3858	2mV \pm 25%
7	2.19979	309.414	2mV \pm 25%	52	65.1405	68.8206	2mV \pm 25%
8	2.39957	293.820	2mV \pm 25%	53	70.1348	66.5012	2mV \pm 25%
9	2.60011	280.526	2mV \pm 25%	54	75.1295	64.3976	2mV \pm 25%
10	2.80351	268.866	2mV \pm 25%	55	80.1257	62.4717	2mV \pm 25%
11	3.00054	259.008	2mV \pm 25%	56	85.1217	60.6953	2mV \pm 25%
12	3.19836	250.262	2mV \pm 25%	57	90.1173	59.0539	2mV \pm 25%
13	3.39988	242.339	2mV \pm 25%	58	95.1150	57.5252	2mV \pm 25%
14	3.59956	235.279	2mV \pm 25%	59	100.118	56.0938	2mV \pm 25%
15	3.80006	228.896	2mV \pm 25%	60	110.098	53.5165	2mV \pm 25%
16	3.99748	223.178	2mV \pm 25%	61	120.092	51.2210	2mV \pm 25%
17	4.19301	217.971	2mV \pm 25%	62	130.093	49.1657	2mV \pm 25%
18	4.61301	208.184	2mV \pm 25%	63	140.088	47.3069	2mV \pm 25%
19	5.01942	200.051	2mV \pm 25%	64	150.086	45.6194	2mV \pm 25%
20	5.52819	191.356	2mV \pm 25%	65	160.085	44.0797	2mV \pm 25%
21	6.24195	181.263	2mV \pm 25%	66	170.089	42.6648	2mV \pm 25%
22	7.05799	171.845	2mV \pm 25%	67	180.087	41.3629	2mV \pm 25%
23	8.08588	162.272	2mV \pm 25%	68	190.082	40.1605	2mV \pm 25%
24	9.09360	154.632	2mV \pm 25%	69	200.088	39.0479	2mV \pm 25%
25	10.1131	148.140	2mV \pm 25%	70	210.096	38.0117	2mV \pm 25%
26	11.1420	142.547	2mV \pm 25%	71	220.095	37.0499	2mV \pm 25%
27	12.1567	137.741	2mV \pm 25%	72	230.091	36.1523	2mV \pm 25%
28	13.1656	133.535	2mV \pm 25%	73	240.098	35.3114	2mV \pm 25%
29	14.1677	129.784	2mV \pm 25%	74	250.091	34.5265	2mV \pm 25%
30	15.1562	126.442	2mV \pm 25%	75	260.112	33.7884	2mV \pm 25%
31	16.1436	123.408	2mV \pm 25%	76	270.099	33.0959	2mV \pm 25%
32	17.1247	120.629	2mV \pm 25%	77	280.104	32.4433	2mV \pm 25%
33	18.1041	118.059	2mV \pm 25%	78	290.108	31.8301	2mV \pm 25%
34	19.0838	115.668	2mV \pm 25%	79	300.117	31.2503	2mV \pm 25%
35	20.0632	113.440	2mV \pm 25%	80	310.124	30.7031	2mV \pm 25%
36	21.1461	111.131	2mV \pm 25%	81	315.135	30.4399	2mV \pm 25%
37	22.7313	108.022	2mV \pm 25%	82	320.137	30.1847	2mV \pm 25%
38	24.3237	105.161	2mV \pm 25%	83	326.132	29.8887	2mV \pm 25%
39	25.9483	102.477	2mV \pm 25%	84	330.128	29.6975	2mV \pm 25%
40	27.5849	99.9786	2mV \pm 25%				
41	29.2145	97.6742	2mV \pm 25%				
42	31.0411	95.2624	2mV \pm 25%				
43	33.1629	92.6735	2mV \pm 25%				
44	36.1702	89.3442	2mV \pm 25%				
45	39.1739	86.3514	2mV \pm 25%				



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UNCERTAINTY ANALYSIS

Calibration Report: 661202
 Sensor Model: CX-1010-CU-1.4L
 Sensor Type: Cernox Resistor

Sales Order: 70293
 Serial Number: X62997
 Temperature Range: 1.40K to 325K

Calibration Data Uncertainty

The uncertainties of the measured calibration data for Lake Shore's sensors are summarized in the table below. The values given are the combined uncertainty of the temperature measurement and the resistance or voltage measurement expressed as an equivalent temperature uncertainty in millikelvin (mK). Note that the values are the calibration uncertainty only and do not include the stability of the temperature sensor. The uncertainty analysis has followed the guidelines for determining measurement uncertainty as outlined in the ISO Guide to the Expression of Uncertainty in Measurement, NIST Technical Note 1297, and ANSI/NCSL Z540-2-1997. Since the uncertainty varies with temperature due to the variation of the sensor sensitivity and excitation, the table gives typical values at several different temperatures throughout the range of the calibration. The uncertainty is based on an approximate 95% confidence level with a coverage factor $k = 2$.

T (K)	Uncertainty (\pm mK)												
	GR	Cernox (CX)					RX			Platinum		RF-800	Diode
		1010	1030	1050	1070	1080	102A	103A	202A	100 Ω	25 Ω	27 Ω	
1.4	4	4	4	4			4	4	4			5	7
4.2	4	4	4	4	4		4	6	5			5	5
10	4	5	5	4	4		10	15	12			7	6
20	8	10	9	8	8	8	35	35	28	9	10	13	9
30	9	13	11	9	9	9	76	61	46	9	9	14	31
50	11	18	14	12	12	11				10	10	13	37
100	20	29	22	17	16	14				11	12	12	32
300		78	60	46	45	36				24	24	25	35
400		124	94	74	72	60				45	45	45	49
500										51	51		54

Polynomial Fit Uncertainty

When a sensor is used to measure temperature, a polynomial fit to the measured calibration data is often used to convert the sensor resistance (R) or voltage (V) to a temperature (T). How well the polynomial represents the sensor calibration data is another source of uncertainty when using the sensor. In the polynomials provided with this set of calibration data, the standard deviation of the fit can be used as an estimate of this additional temperature uncertainty. The standard deviation of fit is determined from the following equation:

$$\sigma_{fit}^2 = \frac{\sum_{i=1}^N (T_i - T_{i,calc})^2}{N - n} = \frac{N}{N - n} (\Delta T_{RMS})^2$$

where

- σ_{fit} = standard deviation of the fit
- T_i = measured temperature for point i
- $T_{i,calc}$ = the temperature calculated from the polynomial equation for point i
- N = number of data points in fit range
- n = number of fit coefficients
- ΔT_{RMS} = root mean square deviation of fit

A value of ΔT_{RMS} is given for each range of fit.

F008-04-00_B (01/17/11)



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F010-04-00_B 06/21/2011

POLYNOMIAL EQUATION

Calibration Report: 661202
Sensor Model: CX-1010-CU-1.4L
Sensor Type: Cernox Resistor

Sales Order: 70293
Serial Number: X62997
Temperature Range: 1.40K to 325K

Polynomial Type: Chebychev
Useful Range of Fit:

1.40 K to 14.2 K
415.8 Ohms to 129.8 Ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:
ZL = 2.09134371392 ZU = 2.66645326985

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	5.893797	1.4394E-04	40945.42
1	-6.653738	2.3033E-04	-28888.33
2	2.594175	2.0242E-04	12815.96
3	-0.786684	2.0720E-04	-3796.74
4	0.186195	1.9902E-04	935.57
5	-0.030100	1.9063E-04	-157.90
6	0.000585	1.8286E-04	3.20
7	0.001563	1.7885E-04	8.74
8	-0.000974	1.7894E-04	-5.44

$Z = \text{Log}(\text{Resistance})$

$k = ((Z - Z_L) - (Z_U - Z)) / (Z_U - Z_L)$

Temp. (K) = $\sum A_i \cdot \text{COS}(i \cdot \text{ARCCOS}(k))$, where $0 \leq i \leq 8$
and the A_i 's are the coefficients in the table above.



POLYNOMIAL EQUATION

Calibration Report: 661202
Sensor Model: CX-1010-CU-1.4L
Sensor Type: Cernox Resistor

Sales Order: 70293
Serial Number: X62997
Temperature Range: 1.40K to 325K

Polynomial Type: Chebychev
Temp. (K) vs. Log(Resistance)

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
1	463.9309	1.20489	1.20482	0.07
2	439.1026	1.29825	1.29861	-0.36
3	416.1993	1.39868	1.39818	0.50
4	379.0253	1.59953	1.59965	-0.12
5	350.5437	1.80029	1.80063	-0.34
6	327.9829	1.99978	1.99987	-0.09
7	309.4142	2.19979	2.19945	0.33
8	293.8196	2.39957	2.39948	0.10
9	280.5263	2.60011	2.59972	0.39
10	268.8659	2.80351	2.80345	0.05
11	259.0078	3.00054	3.00069	-0.15
12	250.2623	3.19836	3.19865	-0.29
13	242.3390	3.39988	3.40002	-0.15
14	235.2786	3.59956	3.60007	-0.51
15	228.8960	3.80006	3.80021	-0.15
16	223.1776	3.99748	3.99731	0.17
17	217.9710	4.19301	4.19334	-0.33
18	208.1843	4.61301	4.61180	1.21
19	200.0513	5.01942	5.01907	0.35
20	191.3562	5.52819	5.52871	-0.51
21	181.2630	6.24195	6.24161	0.34
22	171.8455	7.05799	7.05849	-0.51
23	162.2724	8.08588	8.08655	-0.66
24	154.6321	9.09360	9.09298	0.62
25	148.1402	10.11311	10.11318	-0.07
26	142.5469	11.14199	11.14164	0.34
27	137.7409	12.15672	12.15761	-0.89
28	133.5354	13.16558	13.16401	1.57
29	129.7840	14.16767	14.16791	-0.24
30	126.4416	15.15619	15.15769	-1.50
31	123.4081	16.14356	16.14274	0.83

Order of Fit = 8 RMS error of fit = 0.59 mK
Largest absolute error = 1.57 mK at data point no. 28



POLYNOMIAL EQUATION

Calibration Report: 661202
Sensor Model: CX-1010-CU-1.4L
Sensor Type: Cernox Resistor

Sales Order: 70293
Serial Number: X62997
Temperature Range: 1.40K to 325K

Polynomial Type: Chebychev
Useful Range of Fit:

14.2 K to 80.1 K
129.8 Ohms to 62.47 Ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:
ZL = 1.77124880739 ZU = 2.13906283008

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	43.152266	5.1043E-04	84541.21
1	-38.089843	8.3106E-04	-45832.68
2	7.890019	7.6090E-04	10369.34
3	-0.890792	7.1640E-04	-1243.43
4	0.104989	6.8366E-04	153.57
5	-0.000327	6.4269E-04	-0.51
6	-0.010501	6.4793E-04	-16.21

$Z = \text{Log}(\text{Resistance})$

$k = ((Z - ZL) - (ZU - Z)) / (ZU - ZL)$

$\text{Temp. (K)} = \sum A_i * \text{COS}(i * \text{ARCCOS}(k))$, where $0 \leq i \leq 6$
and the A_i 's are the coefficients in the table above.

POLYNOMIAL EQUATION

Calibration Report: 661202
Sensor Model: CX-1010-CU-1.4L
Sensor Type: Cernox Resistor

Sales Order: 70293
Serial Number: X62997
Temperature Range: 1.40K to 325K

Polynomial Type: Chebychev
Temp. (K) vs. Log(Resistance)

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
27	137.7409	12.15761	12.15581	1.79
28	133.5354	13.16401	13.16593	-1.92
29	129.7840	14.16791	14.16975	-1.83
30	126.4416	15.15619	15.15817	-1.98
31	123.4081	16.14356	16.14144	2.13
32	120.6290	17.12470	17.12185	2.85
33	118.0585	18.10408	18.10260	1.48
34	115.6680	19.08379	19.08382	-0.03
35	113.4404	20.06317	20.06266	0.50
36	111.1312	21.14608	21.14789	-1.80
37	108.0225	22.73128	22.73155	-0.27
38	105.1605	24.32366	24.32539	-1.73
39	102.4770	25.94832	25.94978	-1.46
40	99.97860	27.58490	27.58583	-0.93
41	97.67418	29.21447	29.21022	4.25
42	95.26239	31.04108	31.03968	1.40
43	92.67346	33.16295	33.16504	-2.09
44	89.34420	36.17023	36.17267	-2.44
45	86.35136	39.17387	39.17474	-0.86
46	83.65239	42.15967	42.15818	1.50
47	81.17529	45.16075	45.15728	3.47
48	78.90543	48.15087	48.15205	-1.18
49	77.49012	50.15352	50.15123	2.28
50	74.25434	55.14628	55.14925	-2.97
51	71.38575	60.14471	60.14593	-1.22
52	68.82060	65.14050	65.13770	2.80
53	66.50118	70.13479	70.13930	-4.52
54	64.39763	75.12949	75.12913	0.36
55	62.47174	80.12572	80.12113	4.59
56	60.69534	85.12165	85.12335	-1.70
57	59.05393	90.11727	90.11773	-0.47

Order of Fit = 6 RMS error of fit = 2.22 mK
Largest absolute error = 4.59 mK at data point no. 55



POLYNOMIAL EQUATION

Calibration Report: 661202
Sensor Model: CX-1010-CU-1.4L
Sensor Type: Cernox Resistor

Sales Order: 70293
Serial Number: X62997
Temperature Range: 1.40K to 325K

Polynomial Type: Chebychev
Useful Range of Fit:

80.1 K to 325. K
62.47 Ohms to 29.94 Ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:
ZL = 1.47272000044 ZU = 1.82282934812

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	178.278840	1.5103E-03	118039.91
1	-126.992214	2.3445E-03	-54164.89
2	21.216355	2.2326E-03	9502.79
3	-2.867146	2.1291E-03	-1346.63
4	0.612760	2.0259E-03	302.46
5	-0.119885	2.0289E-03	-59.09
6	0.015409	2.0109E-03	7.66
7	-0.009797	1.9554E-03	-5.01
8	0.003980	1.9330E-03	2.06

$Z = \text{Log}(\text{Resistance})$

$k = ((Z - Z_L) - (Z_U - Z)) / (Z_U - Z_L)$

Temp. (K) = $\sum A_i \cdot \text{COS}(i \cdot \text{ARCCOS}(k))$, where $0 \leq i \leq 8$
and the A_i 's are the coefficients in the table above.



POLYNOMIAL EQUATION

Calibration Report: 661202
Sensor Model: CX-1010-CU-1.4L
Sensor Type: Cernox Resistor

Sales Order: 70293
Serial Number: X62997
Temperature Range: 1.40K to 325K

Polynomial Type: Chebychev
Temp. (K) vs. Log(Resistance)

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
53	66.50118	70.13930	70.13830	1.00
54	64.39763	75.12913	75.13164	-2.51
55	62.47174	80.12113	80.12208	-0.95
56	60.69534	85.12165	85.11989	1.76
57	59.05393	90.11727	90.11044	6.83
58	57.52519	95.11497	95.11219	2.78
59	56.09378	100.11770	100.13350	-15.81
60	53.51647	110.09763	110.09292	4.70
61	51.22104	120.09173	120.09096	0.76
62	49.16570	130.09340	130.08405	9.34
63	47.30687	140.08756	140.09322	-5.65
64	45.61940	150.08610	150.09295	-6.85
65	44.07971	160.08503	160.08139	3.64
66	42.66475	170.08947	170.08777	1.71
67	41.36289	180.08698	180.08807	-1.09
68	40.16053	190.08201	190.08814	-6.14
69	39.04790	200.08840	200.07889	9.51
70	38.01170	210.09643	210.09917	-2.74
71	37.04993	220.09466	220.09137	3.29
72	36.15230	230.09136	230.08822	3.14
73	35.31138	240.09847	240.10793	-9.45
74	34.52652	250.09134	250.09398	-2.65
75	33.78844	260.11248	260.10425	8.23
76	33.09592	270.09885	270.10112	-2.27
77	32.44331	280.10384	280.11366	-9.83
78	31.83011	290.10758	290.09969	7.89
79	31.25028	300.11701	300.11077	6.24
80	30.70310	310.12418	310.11699	7.18
81	30.43988	315.13529	315.14018	-4.88
82	30.18473	320.13718	320.14831	-11.12
83	29.88871	326.13172	326.13890	-7.19
84	29.69751	330.12750	330.11639	11.12

Order of Fit = 8 RMS error of fit = 6.66 mK
Largest absolute error = -15.81 mK at data point no. 59



INTERPOLATION TABLE

Calibration Report: 661202

Sensor Model: CX-1010-CU-1.4L

Sensor Type: Cernox Resistor

Sales Order: 70293

Serial Number: X62997

Temperature Range: 1.40K to 325K

<u>Temp (K)</u>	<u>Res. (Ω)</u>	<u>dR/dT (Ω/K)</u>	<u>dlogR/dlogT</u>	<u>Temp (K)</u>	<u>Res. (Ω)</u>	<u>dR/dT (Ω/K)</u>	<u>dlogR/dlogT</u>
1.400	415.812	-212.56	-0.71568	15.50	125.356	-3.1252	-0.38642
1.500	396.079	-183.20	-0.69382	16.00	123.828	-2.9888	-0.38619
1.600	378.969	-159.92	-0.67517	16.50	122.365	-2.8644	-0.38625
1.700	363.944	-141.17	-0.65942	17.00	120.962	-2.7492	-0.38638
1.800	350.623	-125.76	-0.64564	17.50	119.615	-2.6425	-0.38661
1.900	338.706	-112.94	-0.63356	18.00	118.318	-2.5436	-0.38696
2.000	327.970	-102.08	-0.62251	18.50	117.070	-2.4518	-0.38744
2.100	318.237	-92.799	-0.61237	19.00	115.866	-2.3661	-0.38800
2.200	309.368	-84.771	-0.60283	19.50	114.703	-2.2862	-0.38867
2.300	301.248	-77.785	-0.59388	20.00	113.579	-2.2114	-0.38940
2.400	293.782	-71.660	-0.58541	21.00	111.437	-2.0753	-0.39109
2.500	286.891	-66.263	-0.57742	22.00	109.423	-1.9547	-0.39301
2.600	280.509	-61.479	-0.56984	23.00	107.523	-1.8470	-0.39509
2.700	274.578	-57.221	-0.56267	24.00	105.725	-1.7501	-0.39729
2.800	269.050	-53.412	-0.55586	25.00	104.020	-1.6626	-0.39958
2.900	263.883	-49.995	-0.54943	26.00	102.397	-1.5829	-0.40192
3.000	259.040	-46.914	-0.54332	27.00	100.851	-1.5101	-0.40427
3.100	254.490	-44.128	-0.53753	28.00	99.3753	-1.4432	-0.40664
3.200	250.206	-41.599	-0.53203	29.00	97.9633	-1.3816	-0.40899
3.300	246.163	-39.297	-0.52680	30.00	96.6106	-1.3246	-0.41131
3.400	242.340	-37.194	-0.52183	31.00	95.3128	-1.2716	-0.41359
3.500	238.718	-35.269	-0.51710	32.00	94.0661	-1.2224	-0.41583
3.600	235.281	-33.500	-0.51258	33.00	92.8670	-1.1764	-0.41801
3.700	232.013	-31.872	-0.50828	34.00	91.7124	-1.1333	-0.42015
3.800	228.902	-30.370	-0.50416	35.00	90.5995	-1.0929	-0.42220
3.900	225.936	-28.979	-0.50023	36.00	89.5258	-1.0549	-0.42420
4.000	223.103	-27.690	-0.49645	37.00	88.4889	-1.0192	-0.42615
4.200	217.802	-25.379	-0.48940	38.00	87.4868	-0.98540	-0.42801
4.400	212.932	-23.366	-0.48284	39.00	86.5175	-0.95351	-0.42982
4.600	208.439	-21.603	-0.47675	40.00	85.5792	-0.92334	-0.43157
4.800	204.276	-20.052	-0.47117	42.00	83.7893	-0.86756	-0.43487
5.000	200.406	-18.675	-0.46593	44.00	82.1053	-0.81723	-0.43795
5.200	196.796	-17.449	-0.46106	46.00	80.5172	-0.77160	-0.44082
5.400	193.418	-16.349	-0.45644	48.00	79.0162	-0.73005	-0.44348
5.600	190.249	-15.364	-0.45225	50.00	77.5946	-0.69214	-0.44600
5.800	187.267	-14.471	-0.44820	52.00	76.2455	-0.65739	-0.44834
6.000	184.455	-13.660	-0.44432	54.00	74.9632	-0.62544	-0.45053
6.500	178.071	-11.942	-0.43591	56.00	73.7421	-0.59607	-0.45266
7.000	172.459	-10.557	-0.42848	58.00	72.5774	-0.56893	-0.45466
7.500	167.471	-9.4267	-0.42216	60.00	71.4650	-0.54383	-0.45659
8.000	163.001	-8.4861	-0.41650	65.00	68.8878	-0.48872	-0.46113
8.500	158.959	-7.7008	-0.41179	70.00	66.5628	-0.44264	-0.46550
9.000	155.281	-7.0311	-0.40752	75.00	64.4497	-0.40358	-0.46965
9.500	151.911	-6.4588	-0.40391	77.35	63.5207	-0.38729	-0.47161
10.00	148.809	-5.9624	-0.40067	80.00	62.5169	-0.37054	-0.47417
10.50	145.938	-5.5313	-0.39797	85.00	60.7363	-0.34224	-0.47896
11.00	143.269	-5.1513	-0.39551	90.00	59.0889	-0.31729	-0.48327
11.50	140.779	-4.8167	-0.39347	95.00	57.5583	-0.29541	-0.48758
12.00	138.446	-4.5200	-0.39178	100.0	56.1306	-0.27606	-0.49183
12.50	136.254	-4.2556	-0.39041	105.0	54.7941	-0.25885	-0.49602
13.00	134.187	-4.0128	-0.38875	110.0	53.5391	-0.24345	-0.50019
13.50	132.237	-3.7922	-0.38715	115.0	52.3570	-0.22961	-0.50433
14.00	130.390	-3.6008	-0.38661	120.0	51.2408	-0.21709	-0.50839
14.50	128.632	-3.4331	-0.38700	125.0	50.1842	-0.20570	-0.51237
15.00	126.956	-3.2746	-0.38690	130.0	49.1821	-0.19530	-0.51622



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INTERPOLATION TABLE

Calibration Report: 661202

Sensor Model: CX-1010-CU-1.4L

Sensor Type: Cernox Resistor

Sales Order: 70293

Serial Number: X62997

Temperature Range: 1.40K to 325K

<u>Temp (K)</u>	<u>Res. (Ω)</u>	<u>dR/dT (Ω/K)</u>	<u>dlogR/dlogT</u>	<u>Temp (K)</u>	<u>Res. (Ω)</u>	<u>dR/dT (Ω/K)</u>	<u>dlogR/dlogT</u>
135.0	48.2298	-0.18575	-0.51994	235.0	35.7331	-8.3960e-2	-0.55217
140.0	47.3234	-0.17695	-0.52347	240.0	35.3201	-8.1232e-2	-0.55197
145.0	46.4592	-0.16880	-0.52683	245.0	34.9205	-7.8628e-2	-0.55165
150.0	45.6344	-0.16124	-0.52998	250.0	34.5337	-7.6140e-2	-0.55120
155.0	44.8460	-0.15419	-0.53292	255.0	34.1590	-7.3761e-2	-0.55063
160.0	44.0917	-0.14761	-0.53563	260.0	33.7959	-7.1484e-2	-0.54994
165.0	43.3693	-0.14144	-0.53813	265.0	33.4440	-6.9303e-2	-0.54914
170.0	42.6767	-0.13566	-0.54039	270.0	33.1027	-6.7213e-2	-0.54822
175.0	42.0121	-0.13022	-0.54244	273.15	32.8930	-6.5940e-2	-0.54758
180.0	41.3739	-0.12510	-0.54426	275.0	32.7717	-6.5207e-2	-0.54718
185.0	40.7606	-0.12027	-0.54588	280.0	32.4505	-6.3282e-2	-0.54603
190.0	40.1707	-0.11571	-0.54729	285.0	32.1387	-6.1433e-2	-0.54477
195.0	39.6031	-0.11140	-0.54851	290.0	31.8361	-5.9655e-2	-0.54340
200.0	39.0564	-0.10731	-0.54954	295.0	31.5421	-5.7944e-2	-0.54192
205.0	38.5296	-0.10344	-0.55039	300.0	31.2565	-5.6297e-2	-0.54033
210.0	38.0216	-9.9773e-2	-0.55107	305.0	30.9790	-5.4710e-2	-0.53864
215.0	37.5315	-9.6287e-2	-0.55158	310.0	30.7093	-5.3180e-2	-0.53683
220.0	37.0584	-9.2974e-2	-0.55194	315.0	30.4471	-5.1705e-2	-0.53493
225.0	36.6015	-8.9822e-2	-0.55216	320.0	30.1922	-5.0281e-2	-0.53292
230.0	36.1600	-8.6820e-2	-0.55223	325.0	29.9442	-4.8906e-2	-0.53081



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F010-04-00_B 06/21/2011

THERMAL CYCLE TESTING

Sensor Model: CX-1010-CU-1.4L

Serial Number: X62997

Sensor Type: Cernox Resistor

This sensor was tested for repeatability through rapid thermal cycles from room temperature into liquid helium. During this test, the following four lead resistance values were recorded:

Approximately 305 K:	31.0 Ω
Liquid Nitrogen:	63.6 Ω
Liquid Helium:	218 Ω

The nitrogen and helium values were recorded in OPEN dewars, so precision comparisons with calibration values or other thermal cycle test values should not be made.

Recommended Operating Parameters:

For sensors calibrated by LSCI, the current to the sensor is adjusted to maintain the sensor output voltage or power at the values listed on the Test Data page.



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F010-04-00_B 06/21/2011

BREAKPOINTS 340 FORMAT

Calibration Report: 661202

Sensor Model: CX-1010-CU-1.4L

Sensor Type: Cernox Resistor

Sales Order: 70293

Serial Number: X62997

Temperature Range: 1.40K to 325K

Name: CX-1010-CU-1.4L

Serial number: X62997

Format: 4 ;Log Ohms/Kelvin

Limit: 325.0

Coefficient: 1 ;Negative

Point 1: 1.47630,325.000	Point 56: 1.80785, 75.500	Point 111: 2.22028, 7.650
Point 2: 1.48061,319.000	Point 57: 1.81471, 73.000	Point 112: 2.23013, 7.250
Point 3: 1.48465,313.500	Point 58: 1.82035, 71.000	Point 113: 2.23933, 6.900
Point 4: 1.48877,308.000	Point 59: 1.82613, 69.000	Point 114: 2.24910, 6.550
Point 5: 1.49299,302.500	Point 60: 1.83205, 67.000	Point 115: 2.25954, 6.200
Point 6: 1.49729,297.000	Point 61: 1.83813, 65.000	Point 116: 2.27040, 5.860
Point 7: 1.50169,291.500	Point 62: 1.84438, 63.000	Point 117: 2.28138, 5.540
Point 8: 1.50619,286.000	Point 63: 1.85080, 61.000	Point 118: 2.29318, 5.220
Point 9: 1.51079,280.500	Point 64: 1.85741, 59.000	Point 119: 2.30511, 4.920
Point 10: 1.51549,275.000	Point 65: 1.86422, 57.000	Point 120: 2.31799, 4.620
Point 11: 1.52030,269.500	Point 66: 1.87124, 55.000	Point 121: 2.33105, 4.340
Point 12: 1.52521,264.000	Point 67: 1.87848, 53.000	Point 122: 2.34520, 4.060
Point 13: 1.53024,258.500	Point 68: 1.88522, 51.200	Point 123: 2.35730, 3.840
Point 14: 1.53538,253.000	Point 69: 1.89215, 49.400	Point 124: 2.36846, 3.650
Point 15: 1.54064,247.500	Point 70: 1.89931, 47.600	Point 125: 2.37976, 3.470
Point 16: 1.54602,242.000	Point 71: 1.90670, 45.800	Point 126: 2.39116, 3.300
Point 17: 1.55153,236.500	Point 72: 1.91435, 44.000	Point 127: 2.40336, 3.130
Point 18: 1.55718,231.000	Point 73: 1.92227, 42.200	Point 128: 2.41646, 2.960
Point 19: 1.56296,225.500	Point 74: 1.93048, 40.400	Point 129: 2.42976, 2.800
Point 20: 1.56833,220.500	Point 75: 1.93852, 38.700	Point 130: 2.44317, 2.650
Point 21: 1.57383,215.500	Point 76: 1.94637, 37.100	Point 131: 2.45763, 2.500
Point 22: 1.57945,210.500	Point 77: 1.95450, 35.500	Point 132: 2.47329, 2.350
Point 23: 1.58520,205.500	Point 78: 1.96294, 33.900	Point 133: 2.48919, 2.210
Point 24: 1.59109,200.500	Point 79: 1.97116, 32.400	Point 134: 2.50646, 2.070
Point 25: 1.59711,195.500	Point 80: 1.97970, 30.900	Point 135: 2.52400, 1.940
Point 26: 1.60327,190.500	Point 81: 1.98860, 29.400	Point 136: 2.54314, 1.810
Point 27: 1.60959,185.500	Point 82: 1.99725, 28.000	Point 137: 2.56259, 1.690
Point 28: 1.61606,180.500	Point 83: 2.00627, 26.600	Point 138: 2.58399, 1.570
Point 29: 1.62269,175.500	Point 84: 2.01570, 25.200	Point 139: 2.60581, 1.460
Point 30: 1.62949,170.500	Point 85: 2.02487, 23.900	Point 140: 2.61889, 1.400
Point 31: 1.63646,165.500	Point 86: 2.03372, 22.700	
Point 32: 1.64362,160.500	Point 87: 2.04299, 21.500	
Point 33: 1.65096,155.500	Point 88: 2.05274, 20.300	
Point 34: 1.65775,151.000	Point 89: 2.05999, 19.450	
Point 35: 1.66470,146.500	Point 90: 2.06617, 18.750	
Point 36: 1.67183,142.000	Point 91: 2.07257, 18.050	
Point 37: 1.67915,137.500	Point 92: 2.07873, 17.400	
Point 38: 1.68667,133.000	Point 93: 2.08512, 16.750	
Point 39: 1.69439,128.500	Point 94: 2.09175, 16.100	
Point 40: 1.70234,124.000	Point 95: 2.09813, 15.500	
Point 41: 1.71052,119.500	Point 96: 2.10475, 14.900	
Point 42: 1.71801,115.500	Point 97: 2.11166, 14.300	
Point 43: 1.72571,111.500	Point 98: 2.11886, 13.700	
Point 44: 1.73364,107.500	Point 99: 2.12575, 13.150	
Point 45: 1.74181,103.500	Point 100: 2.13231, 12.650	
Point 46: 1.74813,100.500	Point 101: 2.13915, 12.150	
Point 47: 1.75350, 98.000	Point 102: 2.14630, 11.650	
Point 48: 1.75899, 95.500	Point 103: 2.15380, 11.150	
Point 49: 1.76460, 93.000	Point 104: 2.16169, 10.650	
Point 50: 1.77033, 90.500	Point 105: 2.16916, 10.200	
Point 51: 1.77621, 88.000	Point 106: 2.17701, 9.750	
Point 52: 1.78222, 85.500	Point 107: 2.18530, 9.300	
Point 53: 1.78838, 83.000	Point 108: 2.19406, 8.850	
Point 54: 1.79470, 80.500	Point 109: 2.20231, 8.450	
Point 55: 1.80119, 78.000	Point 110: 2.21102, 8.050	



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F010-04-00_B 06/21/2011

BREAKPOINTS 91C/93C/330 FORMAT

Calibration Report: 661202

Sales Order: 70293

Sensor Model: CX-1010-CU-1.4L

Serial Number: X62997

Sensor Type: Cernox Resistor

Temperature Range: 1.40K to 325K

Interpolation Method: Lagrangian

Limit: 325.0 (Kelvin)

Format: 4 (Log Ohms/Kelvin)

Number of Breakpoints: 51

No.	Units	Temperature (K)	No.	Units	Temperature (K)
1	1.47631	325.0	31	2.12011	13.6
2	1.47702	324.0	32	2.14706	11.6
3	1.48355	315.0	33	2.17263	10.0
4	1.49494	300.0	34	2.19920	8.6
5	1.50703	285.0	35	2.22641	7.4
6	1.51986	270.0	36	2.25059	6.5
7	1.53350	255.0	37	2.27585	5.7
8	1.54802	240.0	38	2.30191	5.0
9	1.56350	225.0	39	2.32824	4.4
10	1.58003	210.0	40	2.35398	3.9
11	1.59773	195.0	41	2.37789	3.5
12	1.61673	180.0	42	2.40567	3.1
13	1.63718	165.0	43	2.42983	2.8
14	1.65929	150.0	44	2.45772	2.5
15	1.68332	135.0	45	2.47892	2.3
16	1.70962	120.0	46	2.50275	2.1
17	1.73873	105.0	47	2.52982	1.9
18	1.77151	90.0	48	2.54484	1.8
19	1.80922	75.0	49	2.56104	1.7
20	1.84598	62.5	50	2.59778	1.5
21	1.86772	56.0	51	2.61890	1.4
22	1.88983	50.0			
23	1.91009	45.0			
24	1.93237	40.0			
25	1.95713	35.0			
26	1.98502	30.0			
27	2.01231	25.7			
28	2.03989	21.9			
29	2.06664	18.7			
30	2.09387	15.9			

Temperature for Resistance Decades:

Res. (Ohms)	Temp. (K)
100	27.568



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F010-04-00_B 06/21/2011

BREAKPOINTS 234 FORMAT

Calibration Report: 661202

Sensor Model: CX-1010-CU-1.4L

Sensor Type: Cernox Resistor

Sales Order: 70293

Serial Number: X62997

Temperature Range: 1.40K to 325K

Maximum Temperature Error:

1.4 - 10K: 0.012K
10 - 20K: 0.019K
20 - 40K: 0.029K
40 - 100K: 0.054K
> 100K: 0.205K

<u>BP #</u>	<u>Temp. (K)</u>	<u>Res. (Ω)</u>	<u>Log10 Res.</u>	<u>BP #</u>	<u>Temp. (K)</u>	<u>Res. (Ω)</u>	<u>Log10 Res.</u>
1	319.854	30.19952	1.480	31	17.271	120.2264	2.080
2	293.614	31.62278	1.500	32	15.330	125.8925	2.100
3	269.846	33.11311	1.520	33	13.610	131.8257	2.120
4	248.170	34.67369	1.540	34	12.091	138.0384	2.140
5	228.308	36.30781	1.560	35	10.757	144.5440	2.160
6	210.026	38.01894	1.580	36	9.587	151.3561	2.180
7	193.149	39.81072	1.600	37	8.562	158.4893	2.200
8	177.523	41.68694	1.620	38	7.663	165.9587	2.220
9	163.022	43.65158	1.640	39	6.877	173.7801	2.240
10	149.539	45.70882	1.660	40	6.187	181.9701	2.260
11	136.995	47.86301	1.680	41	5.581	190.5461	2.280
12	125.320	50.11872	1.700	42	5.047	199.5262	2.300
13	114.465	52.48075	1.720	43	4.577	208.9296	2.320
14	104.380	54.95409	1.740	44	4.162	218.7762	2.340
15	95.049	57.54399	1.760	45	3.794	229.0868	2.360
16	86.419	60.25596	1.780	46	3.467	239.8833	2.380
17	78.459	63.09573	1.800	47	3.177	251.1886	2.400
18	71.126	66.06934	1.820	48	2.917	263.0268	2.420
19	64.400	69.18310	1.840	49	2.685	275.4229	2.440
20	58.234	72.44360	1.860	50	2.477	288.4032	2.460
21	52.596	75.85776	1.880	51	2.290	301.9952	2.480
22	47.433	79.43282	1.900	52	2.122	316.2278	2.500
23	42.715	83.17638	1.920	53	1.969	331.1311	2.520
24	38.399	87.09636	1.940	54	1.831	346.7369	2.540
25	34.454	91.20108	1.960	55	1.706	363.0781	2.560
26	30.854	95.49926	1.980	56	1.592	380.1894	2.580
27	27.571	100.0000	2.000	57	1.489	398.1072	2.600
28	24.587	104.7129	2.020	58	1.395	416.8694	2.620
29	21.885	109.6478	2.040	59	1.309	436.5158	2.640
30	19.451	114.8154	2.060	60	1.229	457.0882	2.660



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